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1945

Unit organization of five topics in pre-flight aeronautics for twelfth grades

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Service Paper

Unit Organization of Five Topics in Pre-Flight Aeronautics for Twelfth Grades

Submitted By

Leon Russell Harvey

(B.P.E. Springfield College, 1917)

In Partial Fulfillment for Requirements

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1945

First Reader: Roy O. Billett, Professor of Education
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THE PURPOSE OF THIS SERVICE PAPER

The teacher of science in the high schools is recognizing more and more the value of applying the principles of mathematics, physics and other sciences in an effort to make these sciences more meaningful and interesting to students. The world has entered upon the "air-age", thus creating a new set of responsibilities for education. The schools are obligated to reorient pupils to the problems arising from the rapid development of transportation by air.

World War II with its vast emphasis on aviation has caused the high schools to attempt to do their part in preparing youth for the job of winning the war, by offering instruction in various phases of aeronautics, and at the same time putting to more practical use the basic sciences of mathematics and physics.

This service problem constitutes an attempt by the writer to organize Units in Pre-Flight Aeronautics with special reference to terrestrial air-navigation. It is based on certain psychological principles which have been derived from the Unit Assignment Course

which is offered in the Boston University School of Education.[1]

Each unit attempts to guide pupils, through class room-laboratory situations, into experiences and activities that are basic to correct educational principles. The unit attempts to organize a subject matter in such a manner that individual class differences are met and pupils develop to their full capacities.

The unit "offers to the teacher a way of growth in service, an incentive to such growth, and a cumulative record of the growth made. It offers to the individual teacher a way of contributing to the general education of all pupils while making a legitimate contribution to the vocational education of some.[2]" Through the medium of the unit, teachers may state their goals in terms of desirable changes they wish pupils to acquire in skills and concepts which would result in higher ideals and attitudes.

Definition of Terms

The delimitation

The delimitation of the unit seeks to state in declarative sentences the learning products which the

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[1] The Unit Assignment in Secondary Education. Roy O. Billett.

[2] Roy O. Billett. The Values of Unit Organization. Fifteenth Year Book, 1942. Eastern Commercial Teachers Assn.

teacher supposes the pupil will acquire in the study of the unit. It sets a limitation or boundary for the teacher to stay within. It is the basis for building related activities, problems, exercises and questions.

The teacher uses the delimitation as the background on which to construct tests for the unit and by checking the results of the objective tests can reteach those sections which pupils have failed to master.

The teacher is guided in his ability to choose words that are within the range of the grade that he is teaching and can easily revise the delimitation for different classes by adding or subtracting from the delimitation and related activities in the unit assignment.

The unit assignment

The unit assignment is "a well organized though preliminary plan for teacher and pupil activity."[1] It should be written in the vocabulary that is usable to the pupils at the time, plus words he is expected to know by the time the unit is completed. It should be challenging and stimulating in its wording and should be problem solving in its nature. It should

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[1]Roy O. Billett. The Values of Unit Organization. Fifteenth Yearbook, 1942. Eastern Commercial Teach. Assn.

include all the means and methods that can be used in the achievement of the unit. It is a plan whereby the teacher can maintain a good balance among the many educative tools at his disposal. He can avoid the error of too much of this or too little of that in his demonstrations, experiments, discussions, lectures, reports, trips and the audio-visual aids at his command. It gives the teacher an opportunity to revise and supplement in accordance with the grade level which he is teaching and gives him an efficient method of enriching pupil growth in the quality and quantity of work of the pupil.

To provide for individual pupil differences the planned activities making up the unit assignment should be grouped under the following heads:

a.) Introductory activities and experiences which should stimulate pupil interests and better teacher understanding of the pupil with reference to the unit.

b.) Core activities in which all pupils, to some extent, have a part to play at the same time.

c.) Optional related activities and experiences, to give each pupil a chance to do something of his choosing and which he takes pleasure in doing. They are optional because no pupil is required to engage in them.

d.) "Selected readings which are to be made available for the pupils during the teaching-learning cycle."[1]

e.) Evaluative activities which include Unit mastery tests and any other means to make known to teacher and pupil what is being achieved.

Optional related activities

The optional related activities, made up largely of problems and projects suggested and prepared by the teacher are a means of assisting the pupil in mastering the unit. These problems and projects may be graded in difficulty to meet the needs, interests and abilities of the pupil in carrying through in the unit.

The optional related activities are not worked on until the pupil has fulfilled the minimum requirements of the unit.

A most valuable use of the optional related activities comes in correlating these activities with other subjects in the curriculum. This correlation can be stimulated by allowing pupils to initiate their own activities. The proper use of these activities requires that each activity be typed on a 2 1/2" by 3 1/2" card and kept on file in a suitable box on the teacher's desk or in a filing cabinet. As the teacher approves activities suggested by the pupils they can

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[1] Roy O. Billett. The Values of Unit Organization. Fifteenth Yearbook. Eastern Commercial Teachers Assn.

be typed and added to the list. Upon completion of the unit a new set of cards is inserted in the box or cabinet to replace the cards of the previous unit.

Testing

The important concepts in most fields of knowledge can be tested through the use of objective tests. It is obvious that not all activities leading to the mastery of the unit can be measured by written examinations. Skills in performance, observation and inspection oftentime form the basis for judging a pupil's worth. Written and oral classwork are used as a measure of ability; but the objective test, written in the form of completion, matching and true and false statements, though not used to assign a mark, do determine the growth and achievement of the pupil.

Time allotment

The time spent on any one unit is tentative and depends largely on the intelligence and learning rate of the individual pupil. Not all pupils can, or should be expected to, work at the same speed; however, a tentative time limit should be set to act as a spur to the completion of the unit.

Class presentation period

Opportunity for the presentation of their work is provided pupils through the class presentation period. Here they give to the class their findings on various

problems and the results of their activities. It is here that pupils get the opportunity of growth through comment and discussion, an invaluable phase of any teaching-learning cycle.

Study guides

Items in the unit assignment that the teacher plans to present to the pupils in some way other than the study guides can be designated by code marks understood by the pupils.

By using a properly designed study guide a teacher can give indirect assistance and help to the entire class and at the same time be of direct help to individuals or groups.

The teacher furnishes one or more study sheets to the pupil to guide him in mastering the unit. These may include statements of introduction, questions, explanations, diagrams, assignments for reading and in fact, all material which the teacher feels will be of help to the student.

Provision for individual differences

In developing the unit and unit assignment, thought must be given to the significant individual pupil differences. Pupils should be allowed to begin at different places in the unit assignment and work at speeds proportional to their abilities. "Pupils are expected to differ in final achievement in the

area represented by any unit because they differ in initial achievement, interest, industry, aptitudes, aims and hence in needs."[1]

The Class

The writer is teaching one class of 15 senior boys in a private school in suburban Boston. These boys come from average middle class families and range in ability from the slow to the fairly bright.

Results of the Otis Self-Administering Test of Mental Ability and the American Council on Education Psychological Examination for High School Students administered during the fall term show the following results:

Pupil	I.Q.	A.C.E. L.	A.	T.
A	125	63	84	74
B	120	80	61	79
C	120	82	63	76
D	112	84	55	82
E	110	49	84	68
F	110	78	39	72
G	108	7	20	8
H	107	84	75	85
I	106	31	51	36
J	106	29	67	40
K	103	46	71	55
L	103	80	66	80
M	101	19	50	24
N	93	29	2	15
O	93	30	18	22

All but one of the boys in the above group face induction into the armed services shortly before or

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[1] Roy O. Billett, Fundamentals of Secondary School Teaching. Houghton Mifflin Co., Boston, 1940.

after graduation. A poll of this group shows a preference for service in the air corps.

Other data available for the group is on file in the office of the headmaster and is accessible to the teacher. These data include participation in extra-curricula activities, marks in the prescribed subjects, music, physical education, art. Records of the results of standardized tests, health records, out-of-school jobs and activities are also available.

In every case the pupils of the class come from English-speaking homes. The occupations of the parents are largely in the business world, with teachers, doctors and lawyers being represented. The out-of-school activities of the group, besides their regular home duties, include membership in the various school teams, membership in the Y.M.C.A., Church Groups and outside clubs. Hobbies play a large part in the outside activities of the group. One member of the class appears regularly on the radio, another has won prizes in art, one is expert in photography and several spend part of their spare time in repair of automobile motors.

The Classroom Laboratory

The classroom laboratory in which the class in aeronautics meets is entirely inadequate, being designed originally as a lecture-demonstration room with a long demonstration table across the front of the room

and the seats or chairs being elevated above the instructor's table in the fashion of an amphitheater. The chairs are movable and of the one-armed tablet variety. Bulletin board space is limited due to too much blackboard area. Floor space is cut down because of the rising platform, making it impossible to add work tables.

Natural lighting is poor as it is a basement room with windows only in the rear; and were it not for good overhead lighting pupils would be forced to work under poor conditions.

Visual aid conditions are adequate, excepting bulletin board space, as a drop screen has been installed and a platform erected for projectors at the back of the room. Black curtains have been installed which adequately darken the room. Power connections are well placed.

The classroom-laboratory library is entirely inadequate as the book cases are being utilized by a collection of materials in use by other science classes that occupy the same room. Filing cabinets for maps and charts are nonexistent and at present the charts are piled on a table in the corner of the room.

More storage space for equipment is badly needed as the school is adding more material from time to time as it is being released by the government. Such items

as used parts of planes, instruments, engines etc. that the Army is releasing to schools for purposes of instruction must have the guarantee of safe keeping, and without adequate storage space, this factor is difficult to insure.

A laboratory classroom work shop we do not possess. Such items as tools, storage space for tools, work benches and the like are needed to carry on a successful program of unit organization.

The school owns a 16 mm. Victor Sound Projector and a 16 mm. Keystone Silent Projector, a combined filmstrip and slide projector and the series of filmstrips developed by the Jam Handy Corporation for Pre-Flight Aeronautics training and instruction.

A Discussion of the Units and Unit Assignments Submitted

Selection

The units which have been submitted are selected from the general topic, "Air navigation", with particular reference to terrestrial navigation.

In order the units are as follows:

a.) Chart Projections
b.) Chart Reading
c.) Contact Flying
d.) Dead-Reckoning
e.) Wind Triangle, Interception, Radius of Action

Air navigation and sea navigation are not unlike in that both have similar problems and make use of methods which are alike. Fundamentally navigation is a matter of direction and distance.

Purpose

In the pre-flight aeronautics course for seniors, the pupils take up approximately twenty-four units which in the teacher's judgment best serve the purpose for desirable adjustment and adaptation of the pupils to their future military service needs.

Five units covering avigation at the high-school level are submitted in this service paper.

Available Textbooks

Each pupil in the class in aeronautics has two

texts at his disposal and from which are selected the materials that are organized for the abilities, interests, skills and needs of the pupils. A carefully chosen collection of basic reference books has been purchased and added to the classroom-laboratory library.

UNIT I

Delimitation of the Unit

1. Navigation has been described as a system for "getting from where you are to where you want to be." We daily put this system into use in a small way in trips to and from our places of schooling or employment and do so without thinking of it in terms of "navigation", but if we contemplate an extended trip or tour by car (in normal times) we plan our trip with the aid of a road map, "navigating" our car by "plotting a course."

2. The pilot-navigator in plotting his course has reference to maps or charts that show him all dangers and aids that he would encounter, and it is imperative that he fully understand the meaning of every symbol on the chart and the system by which positions are determined or located on the chart.

3. In locating one's position on a plane surface it is necessary to have lines of reference running North and West arranged as a grid. On a sphere such as the earth, the lines of reference are derived from the equator or line at right angles to one running between the earth's geographic poles and which cuts the earth into two imaginary parts, and as with any circle is divided into 360°, each degree in 60' (minutes) and each minute into 60" (seconds).

4. If an imaginary line cuts the equator line and passes through the north and south axis of the earth, it divides the earth into two equal parts and is known as a meridian of longitude.

5. Because it is apparent that any number of lines or meridians could intersect the north and south poles, dividing the equator in halves, some one of these lines must be selected as a starting point and designated as the C line.

6. The observatory at Greenwich was adopted by the English as this starting point and designated the prime meridian.

7. Longitude may be measured in degrees up to 180 east or west of the prime meridian, the 180th meridian being the other half of the Greenwich meridian. The position of any point on the earthmay now be definitely expressed as "so many degrees east or west of Greenwich."

8. Parallels of latitude are found by dividing any one of the circles passing through the north and south poles into degrees and by using the equator as a starting point, the intersection of the equator and any one meridian is marked 0°.

9. The degrees north and south of the equator are numbered 1° to 90° and become the North and South Poles.

At any one of these degree marks we may imagine a plane passing through the earth perpendicular to its axis and parallel to the plane of the equator. The intersection of such a plane with the surface of the earth forms a circle around the earth known as a parallel of latitude.

10. With two established reference lines, the equator for latitude and the meridian of Greenwich for longitude, the position of any point on the earth may be located.

11. A great circle is a circle on the earth's surface whose plane passes through the center of the earth dividing the earth into two equal parts. The equator is a great circle as are the meridians. If planes could be passed through the center of the earth in any direction their intersection with the surface of the earth would form great circles.

A parallel of latitude (other than the equator) is found by a plane which does not pass through the center of the earth; consequently such a parallel divides the earth into two unequal parts and is not a great circle. Any circle on the earth, the plane of which does not pass through the center of the earth is known as a small circle, regardless of its size.

12. In air navigation it is important to know the shortest direct route from one point to another.

A taut string stretched between any two points on the surface of a globe will give the shortest distance, or the great-circle course between two points.

13. If the earth is a perfect sphere, the meridians, equator and all other great circles on the earth will be of equal length.

14. All great circles are divided into 360° and each degree into 60 minutes. Each minute of arc of one great circle equals a minute of arc of any other great circle. This unit of measurement, the minute of arc of a great circle, is called a nautical mile and is the unit for measuring linear distance. It is 6080.20 feet in length. This term distinguishes between a nautical mile and a statute mile which is 5280 feet.

15. In converting nautical miles to statute miles and the reverse the following two formulas are used:

$$\text{Distance in statute miles} = \text{Nautical miles} \times 1.15$$

$$\text{Distance in nautical miles} = \frac{\text{Statute miles}}{1.15}$$

16. The system by which lines representing meridians and parallels are transferred to a plane surface is known as a chart projection.

17. No one system of projection can accurately portray all the relationships that exist between features on the curved surface of the earth.

18. To use a chart to the best advantage, one must understand the system of projection on which it was constructed, the purpose of that system of projection and what its good and bad features are.

19. The gnomic or great circle chart has the parallels and meridians projected on a flat surface held tangent to a globe. Any great circle on the globe will project as a straight line.

20. The Mercator may be described as a projection on a cylinder surrounding the globe and taut to it at the equator. After the meridians and parallels have been projected on the inside of the cylinder, it is cut vertically from top to bottom and laid out flat.

21. In this type of chart the distance between parallels of latitude becomes greater and greater as they get further from the equator.

22. The meridians on a Mercator chart are parallel lines instead of converging to a point at the poles. This fact makes the entire top of the chart North and any straight line will cross each meridian at the same angle thereby maintaining for its entire length the same angular relationship with true north.

23. A line between any two points which crosses all meridians of the earth at the same angles is known as a rhumb line and indicates the compass course to be followed from one point to the other.

24. A short line on a globe or gnomic chart is represented as a curved line and in navigating, considerable difficulty is experienced in plotting positions along a curved line.

25. The Mercator projection was devised for the purpose of representing a rhumb line as a straight line.

26. A great circle represents the shortest route between two points and in long distance navigation the route will be plotted on a gnomic chart and then transferred to a Mercator chart, point by point, by latitude and longitude.

27. The distortion of the Mercator projection is such that these points on a great-circle course will form an arc, as though the great-circle course were longer than the rhumb-line course, which of course is not the case.

28. The points on the Mercator chart are connected by a series of straight lines, giving a series of rhumb-line courses to follow in order to approximate the great-circle route.

29. A vessel crossing the ocean may have to change its course only once or twice a day but with a fast airplane a constant compass course could hardly be maintained for over an hour, and the main advantage of the constant compass course or rhumb line ceases to

exist. Therefore the Mercator projection has not been generally adopted for use in air navigation.

30. The Lambert Conformal Conic projection is well adopted to air navigation because it affords a maximum accuracy of directions and distances, greatly aiding the speed and accuracy of solving navigational problems.

31. The Lambert projection is mathematically derived and is developed on a cone which intersects the surface of the earth along two standard parallels, and since the earth and cone coincide at these points, the scale of measurement there is exact.

32. Between the standard parallels, the earth is projected inward upon the cone which is therefore compressed, the scale of the cone being slightly smaller than the scale of the earth.

33. Beyond the limits of the standard parallels, the earth's surface is projected outward on the cone and distortion increases rapidly if the chart extends for any great distance.

34. The standard parallels adopted for aeronautical charts of the United States are latitudes 33°N and 45°N, which latitudes give the least distortion for the area covered.

35. All parallels are represented on a Lambert chart as arcs of concentric circles, their common

center being at the apex of the cone of development.

36. The meridians are represented as straight lines converging towards a common point, also the apex of the cone of development. They are, therefore, radii of the circles of latitude and intersect them at right angles just as they do on the surface of the globe. This makes it possible to represent locations and areas on the chart in their proper relative position, size and shape.

37. The distortion in scale on a Lambert chart is so small that a constant scale of measurement may be used through the entire chart with little error.

38. This makes it possible to represent large areas by many small sections which may be perfectly joined in any direction to form a larger chart.

39. Another advantage of the Lambert chart is that a straight line closely approximates the path of a great circle, and for all practical purposes may be regarded as the shortest route between two points.

40. The one disadvantage of the Lambert chart from the point of view of the pilot-navigator, is the fact that the rhumb line or constant compass course is not represented as a straight line.

41. A rhumb line will vary from a plotted straight line six-tenths of a degree for every 1° meridian crossed and the plotted line course can be followed by

changing the compass course 2° for every 3 degrees of longitude crossed. Such a correction is added when flying from West to East in the United States, and subtracted when flying from East to West.

42. The expression 1:500,000 and 1:1,000,000 used to denote the scale of a chart are read as "one to five hundred thousand" and "one to one million." They represent the proportion existing between the chart and the earth it represents.

43. In one case one unit on the chart equals 500,000 units on the ground. For example, one inch on the chart represents 500,000 inches on the ground, one centimeter on the chart represents 500,000 centimeters on the ground. A chart scale may also be written as a fraction, $\frac{1}{500,000}$ or $\frac{1}{1,000,000}$ and is then referred to as a fractional scale.

44. The area of the United States has been divided in 87 sections, each of which is shown on one of the so-called Sectional Aeronautical Charts. The scale of the sectional charts is 1:500,000 or about eight statute miles to the inch. Thus 1:500,000 means that for every inch on the map 500,000 inches on the earth are represented.

45. Each sectional chart is named for the principal city in the locality it represents, with the exception of a very few which are named after prominent

natural features. They contain all the details needed for use in flying by means of visible landmarks and are also suited to any other type of navigation.

46. The Regional Aeronautical Charts of the United States are on a smaller scale, 1:1,000,000 or about 16 miles to the inch and for long flights with fast planes they are less bulky than the sectional charts, 17 of them covering the entire area of the United States.

47. Regional charts do not contain the detail necessary for piloting and therefore are suitable only for other methods of navigation or for planning routes that extend beyond the limits of one sectional chart. Regional charts are numbered from 1 M to 17 M.

48. The entire United States is represented on one Lambert chart called the Aeronautical Planning Chart. The scale of this chart is 1:5,000,000 or exactly one tenth the scale of the sectional charts.

The Unit Assignment

Introduction

"Air navigation is the science of determining the geographic position and of maintaining the desired direction of an aircraft with respect to the earth's surface."[1] There are various charts designed for use in air navigation. The pilot-navigator must have his maps or charts on which to plot his courses and as they show all aids and dangers to navigation they must be thoroughly understood.

1. Using a globe of the world, review your knowledge of lines of latitude, longitude, the "International Date Line", time belts, degrees, minutes, seconds, nautical miles.

2. Apply the formula for converting statute miles into nautical miles and for converting nautical miles into statute miles.

3. Obtain from your teacher a gnomic or great circle projection chart, a Mercator projection chart and a Lambert Conformal Conic projection chart. Study them in detail, noting their differences and any features that are alike.

4. Ask your teacher to appoint a committee to investigate the sources of Aeronautical Planning Charts, Regional Aeronautical Charts and Sectional Aeronautical Charts. What are the costs per chart?

[1]Aviation Research Group. Columbia University, New York. Science of Pre-Flight Aeronautics for High Schools.

5. Ask your teacher to order enough Sectional Aeronautical Charts so that each member of the class may have one. Also order a sample Regional Chart and an Aeronautical Planning Chart to be used for reference.

6. Do you think it would be of advantage to the class to secure one of the new wall charts that center on the North Pole and show the great circle routes to areas in the Northern Hemisphere? Talk this over with each member of the class. Get his views.

7. Prove to yourself by experimenting with a quarter section of a rubber ball, the impossibility of constructing a perfect chart without distortion.

8. Determine with a piece of string or a ruler that the equator and all meridians appear as straight lines on the gnomic chart and that a line connecting any two points will show the great circle course.

9. Observe that the gnomic chart, except for finding the great circle course, is of little use to the navigator.

10. Upon experimentation with the gnomic chart, do you observe that a straight line course crosses every meridian at a different angle?

11. Find the point of tangency on the gnomic projection chart and note the increase in distortion as you move away from this point.

12. Establish a great circle route on the gnomic chart. Note the latitude and longitude of each point where the route crosses a meridian. Make a note of these figures. They are to be transferred to the Lambert chart later as a navigator would do in actual practice.

13. Referring to the Mercator projection chart note that the distance between the parallels of latitude becomes greater and greater as they get further from the equator thereby causing considerable distortion in high latitudes, thus making it impossible to use any one scale of miles for the entire chart.

14. Find the scale on the sides of the Mercator chart. Does each unit become increasingly longer from bottom to top of the chart?

15. Choose two points some distance apart on the Mercator chart and with a linear scale the length of a minute of arc as found opposite the mean or mid-latitude between the two points in question. Make note of the reading at this point. This is the correct reading for the distance between the two points.

16. Note that a different scale of nautical miles would have to be used for practically every sailing and as the measurement of distance in air navigation is frequent, the use of the Mercator projection for this type of navigation presents a real problem.

17. Prepare a brief summary explaining why a Mercator projection chart is impractical for use in the measurement of distance.

18. Refer to the Mercator chart and observe that the meridians are parallel lines intersecting the parallels of latitude at right angles and that the entire top of such a chart is North.

19. Select two points some distance apart. Connect the two points with a pencil line. Observe that this line crosses all meridians of the earth at the same angle. Measure these angles with a projector to prove this point.

20. From this observation compose a definition of a rhumb line.

21. Draw diagrams to illustrate the difference between a rhumb-line drawn on a gnomic chart and one drawn on a Mercator chart.

22. After a study of the diagram in your text, tell why a Lambert projection is called "conformal conic". Is the cone of projection tangent to the earth, or does it intersect the earth?

23. Locate parallels 33°N and 45°N on the globe and see if you can determine why they have been adopted as standard for the United States.

24. After a study of the Lambert projection determine the one disadvantage of the Lambert chart.

25. Plot a course between two points on a Lambert chart and note that a rhumb-line diverges from the plotted course line. How much does it vary for every 1° meridian crossed? Is the curvature slight or great?

26. Would it be correct to say that a pilot would change his compass course 2° for every 3° of longitude crossed? Would he add this correction if he were flying from west to east and subtract when flying from east to west in the United States?

27. Compose a definition for a great circle. A small circle.

28. Learn the definitions of the following terms:

a. air navigation
b. bearing
c. chart
d. course
e. distance
f. equator
g. geographic poles
h. gnomic chart
i. great-circle bearing
j. Greenwich meridian
k. Lambert chart
l. Mercator chart
m. meridian
n. mid-meridian
o. minute of arc
p. nautical mile
q. parallel
r. rhumb-line
s. statute mile

Suggested Optional Related Activities

1. Ask your teacher to appoint a committee to act in the capacity of an invitation group to invite former students who are in active service as pilots, navigators, or bombardiers or those in training for such duty, to visit the class for discussion. Have them tell of the uses they have made of maps and charts.

2. Why do you think the government has restricted the issuing of aeronautical maps during war time. Write an article on this subject for an English theme.

3. Consult with your history teacher to determine her use of maps.

4. Prepare a sectional map by folding in the manner adopted by aviators. Ask your teacher for instructions. Provide a folder to keep it in.

5. By using the globe map or the Polar map, plot great circle courses between your nearest large airport and cities at or near our fighting fronts. Estimate the distances and closeness to the north pole.

6. Using a wall map of the United States plot the following air distances:

a. Boston to Seattle
b. Boston to Miami
c. Boston to San Antonio
d. New York to Chicago
e. New York to Denver
f. New York to Sanfrancisco
g. Washington to Minneapolis
h. Seattle to Los Angeles

7. Appoint a committee to write to some of the Commercial Airlines for maps showing air lanes that their planes commonly use.

8. Prepare from a wall map of the world the international airways of the world, in operation as late as 1939.

9. Serve on a committee to plan a suitable map and chart cabinet. Inquire into commercial cabinets now on the market or sketch plans and turn over to the manual training department for an estimation of the cost of stock.

10. Read the first ten pages, Part II, of Field and Stetson's Map Reading and Avigation. Prepare a report on your reading.

Indirect and Incidental Learning Products

1. An appreciation of a changed conception of the world through the development of new types of maps.

2. An appreciation of the fact that the airplane has created a new geography.

3. An appreciation of the fact that we are all becoming map conscious.

4. An appreciation of the importance of charts to the aerial navigator.

Standard Tests for Unit 1

Controlled Completion Test

In each numbered space at the right, place the letter indicating the word from the list which best fits the blank having the same number in the sentences below. Use any terms but once.

A. Longitude
B. Latitude
C. Prime Meridian
D. Great Circle
E. Nautical Mile
F. Gnomic Projection
G. Mercator
H. Rhumb-Line
I. Lambert Conformal
J. Sectional Chart
K. Time Belt
L. Parallels
M. Statute Mile
N. Small Circles

Lines of 1_____ running north and south through the poles, if projected would pass through the center of the earth to become 2_____ routes. By agreement Greenwich, England, is the location of the 3_____. The 4_____ chart is accurate for distance and direction without distortion. Large areas are represented by small 5_____ charts. On these charts the 6_____ is not a straight line. Minutes of arc on the equator are called 7_____. Parallels of latitude on the 8_____ projection are further apart as one moves north or south of the equator. 15° of longitude constitutes a 9_____ of one hour. Other than finding the great circle course the 10_____ projection is of little use.

1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9._____
10._____

Completion Test. Unit 1

1. Maps that are used for navigation are called 1._____. 1._____.

2. The line on which the earth rotates is called its 2._____. 2._____.

3. The ends of this diameter where they meet the surface of the earth are called 3._____.

4. A line perpendicular to the one on which the earth rotates and dividing the earth in halves is the 4._____. 4._____.

5. Great circles are of equal length of 5._____ degrees. 5._____.

6. Minutes of arc are called nautical miles and are 6._____ feet long. 6._____.

7. There are 7._____ minutes of arc from the equator to the pole. 7._____.

8. A Lambert projection is called a 8._____. 8._____.
conic.

9. A Mercator projection is a projection on a 9._____. 9._____.

10. The shortest distance between two points on the earth is a 10._____ route. 10._____.

11. A gnomic chart is a projection on a 11._____. 11._____.

12. Lines of longitude are called 12._____.

13. Lines of latitude are called 13._____.

14. Lines of latitude other than the equator are called 14._____ circles. 14._____.

15. There are 15._____ feet in a statute mile. 15._____.

16. The system of transferring lines representing latitude and longitude to plane surfaces is called 16._____. 16._____.

17. Changing statute miles to nautical is called 17._____. 17._____.

18. The Mercator projection was devised to represent a rhumb-line as a 18._____ line. 18._____.

19. The standard parallels adopted for aeronautical charts of the U. S. are 19._____. 19._____.

20. There are 20._____ Sectional Aeronautical Charts covering the United States. 20._____.

Key to Objective Tests

Unit 1. Chart Projections

Controlled Completion Test

1. B
2. D
3. C
4. I
5. J
6. H
7. E
8. G
9. K
10. F

Completion Test

1. Charts
2. Axis
3. Poles
4. Equator
5. 360
6. 6080.20
7. 5400
8. conformal
9. cylinder
10. great circle
11. flat surface
12. meridians
13. parallels
14. small
15. 5280
16. projection
17. conversion
18. straight
19. 33°N--45°N
20. 87

Visual Aids to the Unit

1. Show the 16 mm. film, "Our Earth" issued by the Erpi Film Co.

2. Show the 16 mm. film, "Map Reading" issued by the First Service Command for pre-induction training.

Suggested References

1. "One World--One War", Time, Inc., N. Y., Supplement to Fortune. March, 1942

2. Elementary Map and Aerial Photograph Reading. Manual--First Service Command.

3. Globes, Maps and Skyways.
Hubert A. Bauer.
Air-Age Education Series. MacMillan Co., N. Y., 1942.

4. Human Geography in the Air Age.
George T. Renner.
MacMillan Co., N. Y., 1942.

5. Map Reading and Avigation.
R. M. Field and F. T. Stelson.
D. Van Nostrand Co., Inc., N. Y., 1942.

6. Texts
Science of Pre-Flight Aeronautics for High Schools.
Aviation Research Group. Columbia University.
MacMillan Co., N. Y., 1942.

7. Elements of Aeronautics.
Pope and Otis.
World Book Co., N. Y.

8. "How to Make Maps"
Pamphlet #33 Flight.
American Technical Society
Chicago, Illinois

9. "Airway Maps and Charts"
Pamphlet #34 Flight.
American Technical Society
Chicago, Illinois

UNIT II

CHART READING

The Unit

An aeronautical chart is a representation in small scale of a portion of the earth presenting to the trained eye a description of the charted region more nearly perfect than could be found in the pages of a book. It pictures the landmarks and other information that has been found of value by pilots who have flown many times over the region and become familiar to it. Time spent in learning to read and interpret the detailed information given on aeronautical charts will be of extreme value.

Delimitation of the Unit

1. Two types of features are shown on a chart: (1) topographical: showing inequalities of land surface, bodies of water and all works constructed by man; (2) aeronautical: showing all information and data pertinent to air navigation.

2. Certain features, even on large scale charts must be exaggerated in size. As an example, a small body of water 2,000 to 3,000 feet long and 300 or 400 feet wide would, if depicted at the actual scale, be reduced to a single fine line; therefore it must be

exaggerated in width enough to show a small area of blue color between two shore lines in solid blue. It also must be exaggerated in length to show in general the slope of the body of water. Whenever possible the centers of symbols show their time locations and exaggerated only enough to clearly represent them.

3. On aeronautical charts, water features are represented in blue. The ocean, lakes and pools are of blue tint with the shore line of solid blue. Ponds and lakes which dry up for portions of the year are represented by a broken shore line and are cross-ruled in blue. In sections of the country where dry lakes and ponds can be seen as conspicuous landmarks, these are shown by brown dots enclosed by a broken shore line of blue.

4. Canals and small streams are represented by single blue lines, large rivers by solid blue lines enclosing a blue tint. Intermittent streams are shown by a series of long dashes separated by groups of three dots which suggest scattered pools into which the diminished streams sink during the dry season.

5. Marsh areas are indicated by horizontal blue lines, with scattered groups of short vertical dashes suggestive of clumps of marsh grass.

6. Glaciers are shown by blue shading on the sides of mountains representing the form and flow lines

of the glacial area.

7. Elevation is shown by contour lines in brown. A series of grade tints ranging from green at sea level to dark brown at 9,000 feet.

8. Contour lines are marked with figures in brown italics showing the elevation. A contour line represents an imaginary line on the ground, every point of which is at the same height above sea level.

9. Contour intervals represent successive differences in elevation of 1,000 feet on regional and sectional charts. As additional information to the pilot the highest point of a peak or ridge is generally marked with a black dot and in addition has the elevation given in black figures.

10. Some prominent peaks and steep cliffs are accentuated by shading or hachuring with the elevations marked in black figures. Mountain passes are named and the elevation given.

11. In water areas a six-foot or fathom curve or contour is used to indicate a depth of water that is safe for the largest flying boats.

12. Sand and sand dunes are indicated by brown dots.

13. Cities, towns, railroads, highways and all construction made by man are called cultural features.

14. Towns with a population less than 1,000 are

shown by a black circle. Those with a population of 1,000 to 5,000 are pictured by a yellow square outlined by a thin purple line.

15. Railroads are represented by heavy black lines with crossties at 5-mile intervals. For railroads of two or more tracks the crossties are in pairs.

16. Lookout towers are represented by a solid black triangle in a black circle. The elevation of the ground at the towers is printed in black slanting figures. If the tower has been numbered for identification from the air, the number is printed near the symbol in vertical black figures.

17. Prominent transmission lines are shown by a symbol representing poles or towers with the wires between.

18. Race tracks are shown as oval shapes indicated in black.

19. Airport symbols as well as all aeronautical features are printed in red with the name of the airport and its elevation in slanting red numerals. The letters LF indicate that the field is equipped with lights.

20. Rotating beacons are indicated by a star with open center. If supplemented by course lights they are indicated by arrows pointing the direction of the lights. A nonrotating beacon is indicated by a solid star.

21. On a chart, adjacent to the light symbol, the beacon number and the corresponding code signal which is flashed by the course lights at night are printed in vertical red figures.

22. The course lights flash the code for only the last figure of the beacon number; for example, a beacon flashes the code signal for "4". Beacons 54, 44, 34, etc. are flashing this same signal 100 miles apart.

23. The code used for letters of the alphabet is the standard International Morse Code and the numerals are designated by symbols which also represent a letter in that code.

24. If an airport is equipped with a beacon light, the proper light symbol is placed in the center of the airport symbol. The identifying code signal of the flashing beacon is printed on the chart in code next to the light symbol.

25. In order to distinguish identification signals sent out by radio from those flashed by lights, the radio identification signals are shown on the charts enclosed in a red rectangle.

26. Other radio navigation signals are shown by shaded pink areas. These pink rays extend outward from the position of a radio range station which is represented on the chart by a dot within a small circle.

27. These radio range stations send out the let-

ter N (_.) in the quadrant which includes the direction of north, and also in the opposite quadrant, while in the two other quadrants the letter A (._) is broadcast.

28. Each quadrant slightly overlaps the adjacent quadrants and in the narrow wedge formed by the overlap, the two signals are heard with equal intensity, the dots and dashes interlocking to produce a continuous signal.

29. The shaded pink rays on the chart designate the area in which the "on course" signal is heard, and their direction with respect to magnetic north is marked in red figures.

30. Conspicucus red letters indicate which side of the area is the A or the N zone. The A and N signals are interrupted about twice each minute to broadcast the identification letters of the station. These letters, their code signals, and the frequency of the station are shown on the chart in a rectangle close to the station.

31. All types of radio stations are indicated by the conventional dot in a circle with such data as call letters and frequency in a rectangle nearby.

32. A civil airway is the navigable airspace above a strip of land ten miles on either side of a center line connecting the terminals and intermediate points of an airway.

33. Each side of the twenty-mile wide path is marked on the chart by a double red line. In the vicinity of important airports and the intersection of certain airways where traffic is heavy, the limits of the airways are indicated on the chart by a solid red line.

34. Air traffic in these sections is controlled by an airway traffic control center. If an area is not served by a traffic control center, "control zones of intersection" are established at the intersections of principal airways.

35. These zones are of twenty-five mile radius, usually centered at a radio range station. The limits of such a zone are indicated on the chart by a red circle.

36. Danger zones or "marked" areas are indicated by prominent cross ruling and appropriate notes. "Marked" areas show the same symbol on the ground that appears on the chart.

37. Places at which the magnetic variation is the same in direction and magnitude are connected on the charts by broken red lines known as isogonic lines.

38. Compass roses, oriented to true north, are printed on sectional and regional charts. These roses may be used for the approximate measurement of courses and bearings, if a protractor is not available.

39. Latitude and longitude lines are shown for every half degree, the alternate lines being subdivided into minutes of arc.

40. Nautical miles may be measured by the division of any one of the meridians of longitude, while statute miles may be measured by the scales provided at the top and bottom of the charts.

41. The information on aeronautical charts is complete up to the date of publication which is printed in red in the lower left-hand corner of the chart. A pilot keeps his charts up to date by consulting the "Weekly Notices to Airmen", in which are published any changes in airways, light beacons, radio beacons, or the erection of any obstructions to air navigation.

The Unit Assignment--Chart Reading

Introduction

P. E. James has said, "Like an ant upon a rug (man) may know very exactly the nature of the fabric nearby, but the general design is beyond his range of vision. In order to reduce the large patterns of the face of the e rth to such proportions that they can be comprehended in a single view, the geographer makes use of a map."[1] Each pupil can digest the essence of this quotation.

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[1] Map Reading and Avigation, Field and Stetson, D. Van Nostrand Co., Inc., New York, 1942.

Unit Assignment

1. From a sectional chart, pick out some of the important water and cultural features that you see indicated. Copy the symbols and give their aporoximate locations in latitude and longitude.

2. Using colored crayons, make a color chart and indicate what each color or tint represents.

3. Using a sectional chart, point out the following:

   a. a swampy area

   b. three instances of exaggeration of scale

   c. an auxiliary airport

   d. contours which indicate a gradual slope

   e. contours which indicate a steep slope

   f. contours which indicate a valley, but in which no stream is flowing

   g. a commercial radio station

   h. a radio-marker beacon

4. Using a sectional chart select an airport. Tell the following regarding it:

   a. Elevation

   b. Nature of the terrain within a radius of 5 miles of the airport

   c. What prominent cultural features are prominent in this area?

   d. What would you judge to be the most prominent landmarks in close proximity to this airport?

   e. How close to the center of the nearest city is the airport?

f. How is the airport classified? Is it commercial, municipal, military?

g. Is the airport equipped with lighting facilities for landing at night?

5. Using this same chart, select a "home airport" that is equipped with rotating beacons with flashing code. Answer the following questions regarding it:

a. What is the beacon number and its corresponding code signal?

b. What is the location of the nearest beacon flashing the same signal?

c. On what section of the airway would a pilot fly to follow these beacons?

d. What is the code number used to indicate the letter of the "home airport" beacon?

6. Using a sectional chart choose a "home airport" and a "destination airport" to which you plan to fly. Indicate all the important features which may be of significance to you in your trip. For example:

a. Elevation of your "home airport"

b. Elevation of the more prominent hills along your route

c. What important highway intersections could you use for landmarks?

d. Name the cities or towns over which you fly. What are their populations?

e. Are any of these cities or towns equipped with airports?

f. What are the details regarding these airports?

g. What railroad lines do you follow or cross? What is their nature?

h. What prominent transmission lines do you follow or cross?

i. What is the longitude and latitude of your home airport?

j. What is the meridian nearest the halfway mark?

7. On a chart, how can one distinguish between a code signal flashed by a light beacon and a code signal broadcast by a radio beacon?

8. How is a radio-range course beam indicated on a chart, and what letters are to be found on each side of it?

9. Using a sectional chart choose a "home airport" equipped with a radio range station. Write out an explanation of how you would "fly the beam" into your "home airport."

Optional Related Activities

1. Draw an approximate map using a convenient scale showing the important landmarks between a "home" and "destination" airport. Show only those items that would help you to fly the course in the daytime assuming that you plan to fly in a straight line between the airports and that the ground is visible at all times.

2. Include landmarks and beside each, give its distance in miles from the home airport.

3. Include a north-direction line and the scale value used, and indicate the airports and landmarks with the proper map symbols, names and designations. Make the map as large as possible, using a pencil.

4. Make a list of the areas within a 100-mile radius of a designated "home airport" that are restricted.

5. Prepare an article describing an imaginary trip between two airports designated on a sectional map. Describe the general terrain as you pass over it together with the important cultural features encountered.

6. Read Part I "Map Reading and Avigation" by R. M. Field and H. T. Stetson.

7. After reading "Map Reading and Avigation" answer the following questions:

   a. How many square miles of the United States had been aerophotographed or partly photographed up to 1935?

b. Why were the Canadian pioneers in the use of aerial photography?

c. What has given the principal impetus to the production and use of aerophotographs in the United States?

d. What was the first vertical aerial photograph ever taken?

8. Write a letter to an imaginary friend describing the topography of an area 25 miles around your "home town." Include the towns, railroads, rivers, lakes, mountains, radio beacons and all features that you feel are important. (Use any sectional chart.)

Boston University
School of Education
Library

Indirect and Incidental Learning Products

1. An appreciation of the value of charts to the aviator in navigating.

2. An appreciation of the many types of information to be found on aeronautical charts.

3. An appreciation of the accuracy with which features of the terrain may be reproduced on charts.

4. An appreciation of the part radio plays in aerial navigation.

Mastery Test in Map Reading

Unit II

Multiple Choice Test

Directions: From the four alternate answers given, choose the one answer which you consider to be the best answer. Write the best answer in the space before the statement.

_____1. Contour lines connect points (1) having the same pressure (2) having the same altitude (3) having the same latitude (4) within a low area.

_____2. On aeronautical charts, water features are represented in (1) red (2) brown (3) yellow (4) blue.

_____3. All constructions made by man are called (1) prominent features (2) cultural features (3) visible features (4) permanent features.

_____4. Railroads are represented by (1) black lines with crossties at 5-mile intervals (2) black lines with crossties at 10-mile intervals (3) heavy green lines with crosses at 5-mile intervals (4) lines with the letters R.R. at intervals on the lines.

_____5. Airport symbols are (1) printed in black with the call letters of the airport (2) printed in yellow with the elevation of the airport shown in large yellow numerals (3) printed in red with the name of the airport and its elevation in slanting red numerals (4) printed

in green with the numerals assigned by the government.

_____6. The letters L.F. indicate that a field is equipped with (1) a radio beacon (2) lights (3) control tower (4) fire-fighting apparatus.

_____7. Heavy purple lines on an aeronautical chart indicate (1) canals (2) large rivers (3) prominent highways (4) transmission lines.

_____8. A typical rotating airway beacon light (1) flashes twice every minute (2) burns with a steady glow (3) shows two long and two short flashes every minute (4) shows six clear flashes a minute.

_____9. On a chart adjacent to the light symbol (1) the beacon height and direction of the beam are printed in green (2) the beacon code number and a directional arrow are printed in black (3) the beacon number and the corresponding code signal are printed in red figures (4) the code signal and the beacon signal are printed in blue figures.

_____10. If an airport is equipped with a beacon light (1) the light symbol is placed to the right of the airport symbol (2) the symbol is indicated to conform to the color of the light (3) the beacon symbol is printed in red on the margin of the chart (4) the proper light symbol is placed in the center of the airport symbol.

Recognition Type Test

True and False

Draw a circle around the letter F if the statement is false, around the letter T if the statement is true.

1. Radio identification signals are shown inclosed in a red rectangle. T. F.

2. Radio navigation signals are shown by solid green areas. T. F.

3. The space around each radio range station is divided by beams into four equal quadrants. T. F.

4. Quadrants slightly overlap the adjacent quadrants and in the narrow wedge formed by the overlap signals are heard with equal intensity. T. F.

5. Stations send out the letter N (_.) in the quadrant which includes the direction of East and West while in the two other quadrants the letter A (._) is broadcast. T. F.

6. The A and N signals are interrupted about twice each minute to broadcast the identification letters of the station. T. F.

7. These letters, their code signals, and the frequency of the station are shown in a rectangle close to the station. T. F.

8. A civil airway is the navigable airspace above a strip of land 20 miles on either side of a center line connecting the terminals and intermediate points of an airway. T. F.

9. Each side of this path is marked on the chart by a double red line while in the vicinity of important airports or intersections the lines are marked in solid red. T. F.

10. There are no restrictions regarding flying within zones of intersection and on civil airways. T.F.

11. Airspace reservations and danger areas are indicated on charts by cross rulings and appropriate notes. T. F.

12. High explosive areas should not be flown over except at certain times during the day or night. T. F.

13. "Marked" areas or restricted areas show the same symbol on the ground that appears on the chart. T. F.

14. Places at which the magnetic variation is the same in direction and magnitude are shown on the chart only by the amount and the direction. T. F.

15. Compass roses oriented to magnetic north are printed on regional and sectional charts. T. F.

16. Latitude and longitude lines are shown for every half degree, the alternate lines being subdivided into minutes of arc. T. F.

17. Nautical miles may be measured by the divisions on any one of the meridians of longitude, while statute miles have to be figured by formula. T. F.

18. Because of the convergence of meridians in the Lambert projection, some inaccuracy is introduced if a compass rose is used for the measurement of direction at a point more than 10° to 15° of longitude away. T. F.

19. The information on aeronautical charts is complete only up to the date of one month before publication. T. F.

20. A pilot keeps his charts up to date by consulting the "Weekly Notices to Airmen." T. F.

Key to Objective Tests

Unit II. Chart Reading

Multiple Choice Test

1. 2
2. 4
3. 2
4. 1
5. 3
6. 2
7. 3
8. 4
9. 3
10. 4

Recognition Type Test
True and False

1. T
2. F
3. F
4. T
5. F
6. T
7. T
8. F
9. T
10. F
11. T
12. F
13. T
14. F
15. F
16. T
17. F
18. F
19. F
20. T

Visual Aids to the Unit

Unit II. Chart Reading

1. Regional and Sectional Charts
   U. S. Coast and Geodetic Survey
   Washington, D. C.

2. 16 mm. film "Map Reading" T. F. 5-12
   Army Pictorial Branch
   Headquarters, First Service Command

3. 32 mm. film strips
   "Pilot Problems"
   "Radio and Control"
   Jam Handy Organization
   New York

Suggested References

Unit II. Chart Reading

1. C. A. Bulletin #24
   Supt. of Documents
   Washington, D. C.

2. "The American Student Flyer"
   Hamburg and Tweney

3. "Your Wings"
   Assen Jordanoff
   Funk and Wagnalls, N. Y.

4. Texts
   Science of Pre-Flight Aeronautics for High Schools
   Aviation Education Research Group
   Columbia University
   macMillan Co., N. Y.

5. Elements of Aeronautics
   Pope and Otis
   The World Book Co., N. Y.

6. "Through the Overcast"
   Assen Jordanoff
   Funk and Wagnalls, N. Y.

7. "Elementary Map and Aerial Photograph Reading"
   "Advance Map and Aerial Photograph Reading"
   Field Manuals 21-25 and 21-26
   U. S. Army

UNIT III

CONTACT FLYING

The Unit

When a student has learned to read and interpret charts he is ready to plan a flight by pilotage or piloting. This is the simplest method of flying from one point to another and requires that the student select a set of landmarks easily visible from the plane and flies from one to the other in succession until he reaches his destination. This method is referred to as contact flying.

Delimitation of the Unit

1. In flying an intended course from Airport A to Airport B the first step is to join these two points by a straight line.

2. If the flight is a long one or if the point of departure and the point of destination are not on the same sectional chart, then a regional or planning chart is used on which to draw the line.

3. From the regional chart it can be determined on what sectional charts the proposed course will fall and these charts can then be joined by means of cement.

4. A study is then made of the country over which the course passes to determine if there is any hazardous ground necessitating a detour as it may be advisable to

fly a broken route rather than along a straight course if the former has more convenient landmarks.

5. Along the route finally chosen landmarks are then selected which are to be followed during the flight.

6. In selecting landmarks two things should be kept in mind: (a) they should be clearly visible from the air (b) they should not be too far apart.

7. Cultural landmarks are best and continuous landmarks such as highways, rivers, or railroads should be selected if possible.

8. Two landmarks which are visible at the same time and both on course should be chosen. Keeping them in line while flying is called flying a range.

9. Airfields near the course for emergency landings or refueling should be noted.

10. A log of the trip should be prepared. This should contain five columns. Column 2 lists the landmarks in the order in which they will be reached. Column 2 lists the position of each landmark with respect to the course. Column 3 lists the landmarks as to their distance apart. Column 4 contains the calculated time of arrival at each landmark and Column 5 can be used during flight to record the actual time of arrival at each point or for any remarks which may be considered necessary.

11. In filling in Columns 4 and 5 of the log it is necessary to determine the relation between the distance one travels and the speed and time taken in traveling.

12. Time, distance, and speed can be expressed by formula.

$$T = \frac{D \times 60}{S}, \qquad S = \frac{D \times 60}{T}, \qquad D = \frac{S \times T}{60}$$

Time is expressed in minutes.

13. It is advisable for a pilot to prepare a flight plan for presentation to the traffic authority of the airport he is leaving.

14. The flight plan usually conteins a copy of the log together with information as to (a) type of aircraft (b) name of pilot (c) identification marks of the plane (d) cruising altitudes (e) whether plane is equipped with radio or not (f) time of departure.

15. The traffic authority will contact the destination airport and give them all necessary information and as soon as the pilot lands he will file an arrival message.

16. On the takeoff as soon as the pilot has attained proper altitude he crosses the center of the airfield and records the time in Column 5 of his log and continues on to his first landmark and thence from landmark to landmark as planned.

17. Winds alter the speed of a plane with respect to the ground. A wind blowing in the same direction as the course of the plane is called a tail wind and will increase the ground speed of a plane while a wind blowing in the opposite direction to the course of the plane is called a head wind and will retard the plane and reduce the ground speed.

18. A tail wind or a head wind will not alter the direction of flight but a wind that is neither tail or head and called a cross wind will alter the direction of flight.

19. A pilot keeps the nose of his plane pointed toward a landmark while a cross wind is affecting his plane. In this case the true path of his plane will be curved.

20. If a plane follows a continuous landmark such as a river or railroad and a cross wind is affecting it, the pilot must head partly into the wind to keep on a true course and will consequently have to fly in a skewed position.

21. If the plane follows a curved path the length of the course will be increased, while skewing the plane to follow a continuous landmark will enable the pilot to follow the shortest path between two points.

22. In case a pilot wishes to complete a round trip between Airports A and B he must prepare a log

for the return trip.

23. A pilot figures his fuel consumption in terms of gallons per hour rather than miles per gallon.

24. As a safety measure a pilot allows for 25% more fuel than his calculated needs for long flights and enough extra fuel for 15 minutes additional flying time for short flights.

Unit Assignment

1. Using the distance formula $D = S \times T$, solve the following problem:

If a plane can travel at 110 miles per hour air speed, how far will it travel in 3 hours and 15 minutes? No wind.

2. Using the time formula $T = \frac{D \times 60}{S}$, solve the following problem:

A plane has an airspeed of 120 miles an hour. How long will it take to fly 210 miles? No wind.

3. Using the speed formula, $S = \frac{D \times 60}{T}$, solve the following problem:

A plane flies 140 miles in 1 hour and 20 minutes. How many miles did it travel?

4. With a sectional chart select two airports A and B at least 100 miles apart. Prepare a log for the trip, leaving airport A at 8:00 a.m. with an airspeed of 90 miles per hour. No wind.

5. Do the same for an airspeed of 150 miles per hour with a 20 mile per hour tail wind.

6. Prepare a log for the return trip from airport B to airport A with an airspeed of 100 miles per hour and a head wind of 25 miles per hour.

7. A plane with an air speed (cruising speed) of 110 miles per hour makes a trip of 190 miles and returns in 225 minutes. What is the strength of the wind assuming it to be a tail wind on the way out?

8. In problems 4 and 5, adding 25% for safety, how much fuel will be needed if the fuel consumption is 15 gallons per hour?

9. If a pilot takes 12 minutes to fly between two landmarks 20 miles apart, what is his ground speed?

10. How long will a plane with a cruising speed of 175 miles an hour take to travel 36 miles?

11. Using the Boston Sectional Chart prepare a log for a trip from East Boston Airport Seaplane base to the Wiers on Lake Winnipesaukee, assuming a cruising speed of 105 miles an hour.

Optional Related Activities

1. Select a "home airport" on a sectional chart. Connect this airport by lines extending to four destination airports. Measure and record the distances from the "home airport" to these designated airports.

2. Assuming a follow wind of 30 miles per hour for two courses from the "home airport" and a 20 mile an hour head wind for the two remaining courses with an airspeed of 110 miles per hour, by use of the Time, Speed, and Distance formulas, solve the problem for time, speed and distance for the four courses.

3. From a sectional chart select two airports approximately 75 miles apart. Select suitable landmarks along this route. Measure the distances between landmarks along this route and make a record of these distances.

4. Select three airports a suitable distance apart. Draw up a log for each leg of a triangular course between these airports. Choose your own time of departure and time for rest and refueling between airports. Determine your own cruising speed and wind speed but have a head or tail wind.

Indirect and Incidental Learning Products

1. An appreciation of the necessity of careful chart study for the avoidance of unnecessary hazards.

2. An apprecíation of the importance of good visibility in contact flight.

3. An apprecíation of the value of preparation and schedule.

4. An appreciation of the safety factor both for one's self and for others.

Mastery Tests in Contact Flying

Unit III

Completion Statements

Complete each statement with the correct word or phrase.

1. In flying an intended course from airport to airport the first step is to join these two points by _____.

2. In planning a long flight if the point of departure and the point of destination are not on the same chart, it is necessary to use a _____ chart.

3. Along a route chosen for a flight _____ are selected which are to be followed.

4. Two _____ which are visible at the same time and both on _____ should be chosen.

5. Keeping them in line while flying is called _____.

6. Airfields near the course for emergency landings or _____ should be noted.

7. A log of the _____ should be prepared.

8. This log should contain five columns with column one listing the _____ in the order in which they will be reached.

9. Column two lists the position of each landmark with respect to the _____.

10. Column three lists landmarks as to their _____.

11. Column four contains the calculated _____ at each landmark.

12. Column five is used to record during flight, the actual _____ which may be considered necessary.

13. Complete the following formula: Speed x _____ = Distance.

14. Complete the formula: $\frac{\text{Speed x Time}}{\quad}$ = Distance.

15. Complete the formula: $\frac{\text{Distance x } \_\_\_\_\_}{\text{Speed}}$ = Minutes

16. Wind alters the _____ of a plane with reference to the ground.

17. A wind which is neither a head wind nor a tail wind is called a _____ wind.

18. Fuel consumption for automobiles is figured in _____ per gallon.

19. A pilot figures his fuel consumption in gallons per _____.

20. It is customary to allow _____% more gasoline than is calculated to be needed.

True and False Test

Draw a circle around the letter F if the statement is false, around the letter T if the statement is true.

1. Flying from one landmark to another is called contact flying. T. F.

2. In planning flights pilots use area charts. T. F.

3. In the preparation of a log 3 columns are used. T. F.

4. The first and last landmarks of a trio are the departure and destination points. T. F.

5. Two landmarks visible at the same time and both on course are called a range. T. F.

6. Keeping two landmarks in line while flying is called flying the log. T. F.

7. In flying it is necessary to determine the relation between the distance one travels and the speed and time taken in traveling. T. F.

8. The distance formula is stated as

$D = \frac{S}{T}$ T. F.

9. The speed formula is stated as

$S = \frac{D \times 60}{T}$. T. F.

10. The time formula is stated as

$T = \frac{D \div 60}{S}$. T. F.

11. Charts in use by pilots are rolled so that they can be easily used. T. F.

12. A wind which blows in the same direction as the course of the plane is called a tail wind. T. F.

13. If the nose of a plane is kept pointed toward a landmark with a cross wind blowing its true path will be an angle. T. F.

14. If a return trip is planned it is not necessary to prepare a log. T. F.

15. The time for a round trip in which the wind affects the ground speed of the plane will always be greater than the time when there is no wind effect. T. F.

Key to Objective Tests
Unit III
Contact Flying

Completion Test

1. a straight line
2. regional
3. landmarks
4. landmarks, course
5. flying a range
6. refueling
7. trip
8. landmarks
9. course
10. distance apart
11. time of arrival
12. time of arrival, remarks
13. time
14. 60
15. 60
16. speed
17. cross
18. miles
19. hour
20. 25

True and False Test

1. T
2. F
3. F
4. T
5. T
6. F
7. T
8. F
9. T
10. F
11. F
12. T
13. F
14. F
15. T

Visual Aids to the Unit

1. Show the 35 mm. film strips:

"Air Pilotage"

"Airway Aids"

"Pilot Problems"

Jam Handy Organization, N. Y.

Suggested References

Unit III. Contact Flying

1. "Practical Air Navigation"
Thoburn C. Lyon
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2. "Air Navigation"
Weems, P. V. H.
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3. "Air Pilot Training"
Shield, Bert A.,
McGraw-Hill Book Col, N. Y.

4. "Through the Overcast"
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5. Texts.
"Elements of Aeronautics
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"Science of Pre-Flight Aeronautics"
Aviation Education Research Group
Columbia University. MacMillan Co., N. Y.

UNIT IV

DEAD-RECKONING

The Unit

Dead-reckoning navigation is the act of determining an aircraft's position by means of the measure of direction and distance from the point of departure or last known position.

Delimitation of the Unit

1. On the chart, a straight line joins the point of departure and the point of destination, then by comparison with the scale of miles at the top or bottom of the chart, the length of the course line can be determined.

2. The direction of the course line is expressed by the angle the line makes with a meridian. Such an angle is always measured clockwise from the true North or 0° around through 360°.

3. For measuring air angle the navigator uses a protractor, an instrument graduated from 0° to 180°. Every student of navigation must possess a protractor and learn to use it accurately.

4. Students of navigation must learn to distinguish between two different kinds of direction, the direction of a bearing and the direction of a course. A

bearing is the direction of a great circle or the direction of the shortest distance between two points on the surface of the earth.

5. Because the meridians converge towards a point above the chart a straight line intersects each meridian at a different angle.

6. In order to find the correct rhumb-line or constant compass direction to fly from A to B or B to A, the navigator measures the angle the course line makes with the meridian nearest halfway between the two points.

7. When the difference of longitude between two points is considerable the straight line on the chart should be divided into sections of not more than 3° or 4° of longitude each. The true course to be flown for each section is then measured at the mid-meridian of that section.

8. The earth, with its north and south magnetic poles, is like a huge magnet surrounded by a field of magnetic influence. The effect of this field causes the needle of the compass to point toward the magnetic north pole.

9. There are two north poles on the earth: the geographic or true north pole towards which the meridians point and the magnetic north pole towards which the compass points.

10. It has been determined that the earth's magnetic north pole is close to Lat. 71°N, Long. 96°W, which point is about 1300 miles from the geographic pole.

11. The number of degrees by which a compass pointsaway from the true north at any given locality is called the variation for that locality.

12. In localities in which the compass needle points east of true north, the variation is said to be easterly and when the compass needle points to the west of true north, the variation is westerly.

13. In order to find the variation for any locality, the pilot will find on his air chart broken red lines marked with the variation. These might be considered like contour lines joining points of equal magnetic variation instead of points of equal elevation. Such a line is called an isogonic line which means that the angle between the true north and magnetic north is always the same, measured at any point along the line.

14. The metal, motor, and various electrical currents in instruments near the compass all act on the compass and cause it to deviate from its correct magnetic reading. The number of degrees that the compass needle deviates to the left (west), or to the right (east) of the direction of magnetic north is called deviation.

15. Whereas variation will affect all compasses in the same locality in the same way, deviation will differ on different compasses.

16. Variations change with a change of location while deviation changes with a change in direction.

17. Once a compass has been installed in an airplane, the deviation of the compass is checked for various headings or directions. This is done by a process called "swinging ship." The plane is jacked up level, the motor started, radio and lights turned on, everything done to initiate level flying conditions.

18. The aircraft is then headed in a known magnetic direction, North 25°, 50°, 75° etc. and the deviation noted for each heading.

19. Large errors of deviation are corrected as far as possible by small compensating magnets in the compass that are adjusted by screws. The amount of error in degrees that still remains is tabulated in a deviation curve or graph.

20. A deviation card, made out from the graph, is posted in the plane near the compass to aid the pilot in converting a magnetic course to a compass course.

21. In changing a true course to a magnetic course it is first necessary to find the variation from the chart and the deviation from the deviation card.

22. To find the compass heading it becomes

necessary to consider the wind velocity (speed and direction).

23. The angle between the planes intended course and the actual course or track it did take due to the wind is called the drift angle.

24. To correct such an error, the plane must head into the wind a sufficient amount so as to counteract the effect of that wind and thus fly the intended course.

25. The angle at which a plane must head into the wind in order to make good the intended course is called the wind correction angle.

26. After the wind correction angle has been applied we shall have a new direction, that in which the aircraft should be pointed.

27. Such a direction is called a heading to distinguish it from a course, which is the direction of a line plotted on the chart.

28. The heading of a plane may be measured with reference to true north, in which case it is called a true heading.

29. If measured from magnetic north it is called magnetic heading.

30. If measured from the compass north it is called a compass heading.

31. As with variation and deviation the wind

correction angle is sometimes to be added, sometimes to be subtracted. Which is done will depend on whether the correction for the effect of the wind increases or decreases the angle which measures the direction of the course line.

32. No matter what direction the plane is flying ing, if the wind is blowing from the right of the plane it is called a right wind; if blowing from the left, a left wind.

33. To correct for the effect of the wind, a pilot must head his plane to that side of his course from which the wind is blowing.

34. No matter what the direction of the course, heading the airplane to the right of the course to correct for a right wind will increase the angle measured from north and therefore the wind correction angle is to be added. With a left wind the reverse is true and the wind correction angle is to be subtracted.

35. In applying the wind correction angle it is necessary to also apply the variation giving us the magnetic heading and then the deviation, giving us the compass heading.

36. Another method would be to correct for variation and deviation first, and then apply the wind correction angle to the compass course in order to get the compass heading.

37. For exact navigation the wind correction angle should be applied first.

38. In carefully determining a course the following form should be used:

TC Wind TH V MH D CH

and the figures noted before the flight starts.

39. If while in flight the strength and direction of the wind change thereby putting the plane on a different course the pilot will reverse his previous process of figuring. He will apply the corrections for deviation as given on the deviation card and variation, as found on the chart, in reverse. This reverse process is known as rectifying.

Unit Assignment

Introduction

Dead reckoning refers to the finding of distance and of direction to one's destination with the aid of charts and directing the plane by means of the compass. It involves finding the required heading of the plane to allow for wind drift and finding oneself (a fix.) from which a distance and direction may be measured.

1. Using a sectional chart, locate points A and B some distance apart. Draw a pencil line between these two points. Compare this line with the scale of miles at the top or bottom of the chart. What is its distance? Find the compass rose on your chart nearest the line drawn. With your parallel rulers or triangle, determine the angle, by reading clockwise on the compass rose, the line makes with the nearest meridian.

2. Airport B bears 125° (true) from Airport A and is 180 miles from it. On a Lambert air chart of the United States, is the true course 125°? On a Mercator chart, is the true course 125°?

3. A course line on a regional chart starts at Longitude 70°W and ends at 78°W. At what point should the direction of the true course be measured?

4. If a pilot were to plan a flight of 1000 miles from a southern airport in a direction of true north, would it be necessary to subdivide this route? If so,

at approximately what points?

5. A pilot plots a course from point A due east to point B. Tell whether it would be necessary to subdivide the route and if so, at approximately what points?

6. Write out a definition of variation and state the rule for its application to flight planning.

7. In writing, tell the difference between a true course and a true heading.

8. Select the Boston Sectional Chart and prepare a compass work form for the following problem: In flying from Boston along the radio beam in a direction of 345° what would be the magnetic course?

9. A certain section of a course has a direction of 265° true. The section is crossed by isogonic lines showing 17°W, 16°W, 15°W, 14°W, and 13°W variation. What is the magnetic course?

10. Supposing a true course of 45° were being flown, should the wind correction be added or subtracted for a wind from (a) 15°? (b) 185°? (c) 314°? (d) 225°?

Optional Related Activities

1. What words should be memorized for use with a compass work form?

2. Have the teacher appoint someone to look up information relative to the changes in isogonic lines from year to year. Prepare a report for the class.

3. Why is a compass course never printed on a chart?

4. Tell in writing what words should be memorized for use with a compass work form.

5. If you find your true course from your compass course or heading, tell what the process is called.

6. Using the deviation table in your text (Fig. 549) and the Boston Sectional Chart, what is the compass course for a flight (a) along the radio beam from Boston towards Portland, Maine? (b) from Boston towards Manchester, N. H.? (c) from Boston towards Hyannis, Mass.?

7. Using the Boston Sectional Chart find the radio range course from Boston to Portland, Me. Draw a line on the center of the radio beam until it intersects 70° 30' meridian. Measure the direction of the radio beam at this point and account for the fact that the beam is marked 217°.

8. The following problems are to be arranged in

compass work form and the unknown quantities found.

	TC	TH	MH	CH	Var.	Dev.	Wind
a.	88	...	...	...	10E	4W	5R
b.	252	...	...	...	15W	6E	8L
c.	...	...	...	024	10E	3E	5R
d.	048	...	...	075	16W	4W	...
e.	165	...	...	165	8E	...	4R
f.	...	...	085	...	10E	3E	5L
g.	260	...	...	285	15W	4W	...
h.	...	...	012	...	13W	8E	3L

Indirect and Incidental Learning Products

1. An appreciation of the importance of dead reckoning to the pilot in determining the direction and distance he has to fly.

2. An appreciation of the importance of basic mathematical formulas in computing time, distance and speed.

3. An appreciation of the close co-ordination between instruments and charts in flying.

Mastery Test in Dead Reckoning

Unit IV

One word answer recall test

In the test below you will find at the left hand certain statements and at the right certain words. Pick out from the list of words the one which fits a particular statement. Place the number of the word in the space to the left.

_____A. The direction of one object from another.

_____B. The angular difference between the magnetic heading and the compass.

_____C. A circle on the earth's surface made by a plane passing through the center of the earth.

_____D. The course of a plane in its path of flight reckoned from magnetic north.

_____E. Any wind coming from the right of the longitudinal axis of an aircraft.

_____F. The meridian passing through a point halfway between two places.

_____G. An instrument for measuring and laying off angles.

1. meridian
2. clockwise
3. true north
4. protractor
5. compass rose
6. course
7. bearing
8. great circle
9. mid-meridian
10. magnetic north
11. variation
12. magnetic course
13. deviation
14. wind correction angle

_____H. The direction over the surface of the earth that an aircraft is intended to travel.

_____I. A circle on the earth's surface formed by a plane passing through the earth's axis.

_____J. The angle between the track of an aircraft over the ground and heading of the aircraft.

_____K. The north of the earth's magnetic field.

_____L. A circle, graduated in degrees, like a compass card placed on charts as a means of ascertaining direction.

_____M. Like the motion of the hands of a clock.

_____N. The angle between the true meridian and the magnetic meridian.

_____O. A written record of navigational data, which may be either computed or observed.

_____P. The speed of an aircraft relative to the air.

_____Q. The direction of an object expressed as an angle measured clockwise from the heading of an aircraft.

15. right wind
16. left wind
17. alignment
18. compass course
19. compass heading
20. ground speed
21. air speed
22. heading
23. isogonic lines
24. log
25. projection
26. relative bearing
27. fix.
28. true course
29. relative wind

_____R. A position determined by the intersection of two or more lines of position or bearings.

_____S. The velocity and direction of the air with reference to a body in it.

_____T. The direction of a course reckoned from true north.

Key to Objective Tests

Unit IV

Dead Reckoning

One word answer test

A. bearing

B. deviation

C. great circle

D. magnetic course

E. right wind

F. mid-meridian

G. protractor

H. course

I. meridian

J. wind correction angle

K. magnetic north

L. compass rose

M. clockwise

N. variation

O. log

P. airspeed

Q. relative bearing

R. fix.

S. relative wind

T. true course

Visual Aids to the Unit

Unit IV

Dead Reckoning

1. Show the 32 mm. filmstrips

"Dead Reckoning"

"Pilot Problems"

"Air Pilotage"

Jam Handy Organization, N. Y.

Suggested References

Unit IV

Dead Reckoning

1. "Air Navigation"
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Washington, D. C.

2. "Air Navigation and Meteorology"
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3. Careers in Aviation
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4. "Flight Training for Army and Navy"
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5. "The Student Pilots Training Primer"
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D. Van Nostrand Co., 1941
New York

6. "How to Get a Job in Aviation"
Matton, C. S.
Air Youth of America, 1940
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7. "Simplified Theory of Flight"
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D. Van Nostrand Co., Inc., 1941
New York

UNIT V

WIND TRIANGLE, INTERCEPTION, RADIUS OF ACTION

Delimitation of the Unit

The Unit

A complicating factor in airplane flight is the effect of wind on the plane. The two forces acting on the plane; the pull of the propellor and the force of the wind; can be plotted by constructing a wind triangle.

1. When two forces that are not parallel act on an object at the same time, the object will move in a direction different from that of either force.

2. Knowing what has happened to the object, a single vector can be constructed which will represent a single force that would have the same effect on the object as the two forces, working together, did.

3. A triangle with sides equal to the airspeed vector of the plane and the wind vector in miles per hour is constructed.

4. The third side will give the direction and speed of the plane with respect to the ground. The length of this side of the triangle is the "ground speed" and the direction the true ocurse or track of the plane. This triangle is called a "wind triangle".

5. All angles are measured from a line running north and south called a north-south line.

6. Using a convenient scale, a wind speed vector is constructed. From the end of the wind vector and using the same scale an airspeed vector is constructed.

7. The distance from the point of departure to the point on the line intersected by the airspeed line is measured and gives the ground speed.

8. Finding the true heading and the ground speed is probably the most important type of fundamental problem confronting the aviator.

9. The angle between the true heading of a plane and its true course is called the drift angle.

10. If a plane is to fly along a given true course and makes a correction in its heading to compensate for wind action, the resulting angle is called the wind-correction angle.

11. In finding the compass heading and the ground speed it is necessary to correct the true heading for variation and deviation.

12. In solving wind-drift problems it is necessary to draw lines carefully to scale.

13. If the student wishes to represent miles on a sheet of paper he may let one-sixteenth of an inch represent a mile, or let one millimeter represent a mile, or let one inch represent 10 miles.

14. For scale drawing it is most convenient to have a decimal scale such as a metric inch with inches divided into tenths.

15. A group of problems relating to the overtaking of a moving body such as a ship, train, or another airplane which it is valuable to understand are called interception problems.

16. The term "bearing" has been defined as the direction of one object from another expressed as an angle measured from true north.

17. A second type of bearing used in navigation called a relative bearing is used to measure the relation to the direction or heading of an aircraft instead of with respect to true north.

18. If two objects move in such a manner that the relative bearing of one from the other is always the same, it is said that the objects are traveling with constant bearing or on a collision course.

19. A number of different situations which can arise under the head of interception problems may be stated under the following headings and treated as part of the unit assignment.

20. The problems treated are:

(a) Overtaking, without wind

(b) Overtaking, with wind

(c) Interception at a given point, without wind

(d) Interception at a given point, with wind

(e) Interception in a given time, without wind

(f) Interception in least time, without wind

(g) Interception in least time with wind

(h) Interception of planes

21. Frequently, after a pilot has set forth on a flight toward a fixed destination, circumstances arise which make it necessary for him to turn back or to seek a landing at an alternate base. This procedure is called "Radius of Action".

22. The "Radius of Action" of an airplane is the distance it may fly with a given airspeed and fuel load, and from which the plane is able to return to the starting base or an alternate base.

23. In problems of Radius of Action the pilot knows his ground speed out and his ground speed in to the base. He is also given a definite time (in hours) to complete his assignment.

24. In finding Radius of Action, a pilot makes use of the formula:

$$R.A. = \frac{G.S.O. \times G.S.I.}{G.S.O. + G.S.I.} \times T$$

25. The different situations confronting a pilot and involving Radius of Action may be stated under the following headings and treated as part of the unit assignment.

26. The problems considered are:

(a) Return to the same base

(b) Return to the same base with a head or tail wind

(c) Return to the same base, with a cross wind

(d) Return to alternate base, without wind

(e) Return to alternate base, with wind

(f) Alternate base: one hour diagram

Unit Assignment

Introduction

Making use of calculations based on the velocity and direction of the wind, together with a knowledge of distance and direction, is the chief concern of the pilot in flying from place to place. Insofar as a pilot gains competence in the abilities and skills necessary to the solving of basic problems of avigation, does he become more expert as a pilot.

1. Let us suppose that a plane is heading in the direction of 42° with an air speed of 95 miles an hour. There is a wind blowing from 165° at 25 miles an hour. What is the course and what is the ground speed of the plane?

2. A pilot wishing to fly from one base to another plots his true course and finds it to be 255°. His air speed is 150 miles an hour and he knows the wind is blowing at 20 miles an hour from 345°. What is his true heading and ground speed?

3. A plane is to fly a true course of 68° for a distance of 275 miles. The air speed is 125 miles an hour and there is a wind of 30 miles an hour from 15°. The variation is found from the chart to be 15°W and the deviation is 3°E. What is the compass heading, ground speed, and time of flight? (Make use of the Time formula. $T = \frac{D \times 60}{S}$.

4. Let us suppose we are flying along a railroad known to extend in a direction of 95°. We know the wind is blowing from the southeast; the compass indicates that we are heading in the true direction of 105° (compass reading corrected for variation and deviation). Assuming an air speed of 100 miles an hour, what is the speed of the wind?

5. Suppose we are in flight and wish to determine the wind velocity (speed and direction). We are flying with a heading of 290° and note a drift angle of 8° to the right. We fly a few moments with a heading of 190° and note a drift angle of 12° to the left. Our air speed is 105 miles an hour. What is the wind speed and direction?

6. An airplane flying a given course leaves its base at a ground speed of 125 miles per hour. A second plane leaves the same base one hour later and after flying for two hours overtakes the first plane. What was the ground speed of the second plane? (Use the distance formula: $D = S \times T$.)

7. Suppose that one plane leaves its base with a ground speed of 105 miles an hour and that another plane follows it from the same base at 125 miles an hour. How long will it take the second plane to overtake the first?

8. A ship sails from a port A at 7:00 a.m. on a course of 50° with a speed of 20 miles an hour. A plane with an air speed of 95 miles per hour leaves three hours later on the same course to overtake it. When and where will the plane overtake the ship if there is a wind blowing from 120° at 30 miles an hour?

9. A ship leaves Port A on a course of 210° at 25 miles an hour. A plane is to leave an airport bearing 110° from the port and 80 miles from it. If the air speed of the plane is 140 miles an hour, how long will it take to intercept the ship 250 miles from shore? (No wind)

10. An airport is 75 miles from a seaport and bears 80° from it. A ship leaves the port at 1:00 a.m. on a course of 295° at 30 miles an hour. At what time must a plane leave the airport in order to overtake the ship 350 miles from port if the plane has an airspeed of 140 miles an hour and there is a wind of 25 miles an hour blowing from 45°?

11. An airport B bears 140° from a seaport A and is 75 miles from it. A ship leaves A at midnight on a true course of 95° at 30 miles an hour. When may a plane with an air speed of 110 miles an hour leave B and overtake the ship in 3 hours if there is a wind of 30 miles an hour from 10°?

12. A ship leaves a port A at 7:00 a.m. on a true course of 85° at 25 miles an hour. At the same time, a plane leaves airport B 175 miles away and bearing 210° from Port A. If the speed of the plane is 100 miles an hour and there is a wind of 30 miles an hour blowing from 40°, how long will it take the plane to meet the ship?

13. A bomber has been reported as traveling at 250 miles an hour (ground speed) on a true course of 285° by a spotter at point A. A pursuit squadron leaves Airport B, bearing 165° from A and at a distance of 140 miles from it. The pursuit planes have an air speed of 325 miles an hour and there is a 35 miles an hour wind from 110°. What heading must the squadron follow in order to intercept the bomber as soon as possible, and how soon will the squadron make this interception if it starts 15 minutes after the report is received?

Optional and Related Activities

1. Solve the following problems.

   (a) A wind of 25 miles an hour is blowing from 230°. A pilot wishes to make good a true course of 110° and plans to fly with an air speed of 90 miles an hour. Draw the diagram and answer the following questions.

   (1) What is the ground speed?

   (2) What is the drift angle?

   (3) What is the true heading?

   (4) How long will it take him to go 200 miles in hours and minutes?

   (b) A pilot wishes to fly at an air speed of 110 miles an hour from A to B which is 175 miles away. Bearing of B from A is 125°. A wind, indicated to have a speed of 25 miles an hour is blowing from the south. The compass variation is 8°E; the deviation is 5°W. Draw the diagram and answer the following questions.

   (1) What is the ground speed?

   (2) What is the flight time in hours and minutes?

   (3) What is the magnetic course?

(4) What is the compass course?

(5) What is the compass heading?

(6) What is the true heading?

2. Using the Boston Sectional Chart, solve the following problem:

A cruiser leaves Portland, Me., harbor on a course of 85° at 35 miles an hour. An Army pursuit plane with an air speed of 250 miles an hour leaves East Boston Airport at the same time to intercept the ship. How long will it take the plane to meet the ship?

3. Using the Boston Sectional Chart, solve the following problem:

A ship leaves Boston harbor at 12:00 noon with a speed of 25 miles an hour and bearing for the tip of Cape Cod. At what time must a plane leave East Boston Airport in order to overtake the ship 5 miles off the tip of Cape Cod if the plane has an air speed of 125 miles an hour and there is a wind of 30 miles an hour from 110°?

4. Using the Seattle Sectional Chart solve the following problem:

A plane with an airspeed of 125 miles an hour and enough fuel for four hours of actual flight proceeds on a course from the Seattle airport with Yakima as its bearing. If the wind is 30 miles an hour from 340°, find the radius of action and the time of turn to return to the Seattle airport.

5. Again using the Seattle Sectional Chart solve the following problem:

A plane is required to fly from Seattle to Ellensburg. It has an airspeed of 105 miles an hour and carries fuel adequate for 2 hours flying. There is a 20 miles an hour wind blowing from 190°. During the flight the pilot is told by radio that the Ellensburg Airport is closed because of fog as is the Yakima Airport. He is also told that fog has closed in on the Seattle Airport and for him to return to Tacoma. Answer the following:

(a) What was his heading out?

(b) What was his heading back?

(c) What was his turning point?

(d) What was the distance to the turning point?

Indirect and Incidental Learning Products

1. An appreciation of the necessity of exactness in plotting and measuring diagrams for accuracy.

2. An appreciation of the forces that are operating on a plane in flight and the necessity of careful planning to cope with these forces.

3. An appreciation of the value of fundamental formulas for speed and simplicity of calculation.

Mastery Tests in Interception, Radius of Action and Wind Triangles

Unit V

Recognition Test. True and False Test. Draw a circle around the letter F if the statement is false, around the letter T if the statement is true.

1. The speed of a plane along its track is called the ground speed. T. F.

2. The ground speed of a plane is always somewhat less than the air speed. T. F.

3. To find the track of a plane when we know the heading, the air speed, and the wind velocity, we need to solve a triangle, knowing the length and the direction of one side and the directions but not the lengths of the other two sides. T. F.

4. To find the heading of a plane, when you know the direction of the desired course and the wind velocity, we need to solve a triangle, knowing the length of two sides and their direction. T. F.

5. If the wind is from the east at 25 miles an hour, the drift angle with reference to a heading to the northeast is the same as the correction angle with reference to a desired course to the northeast. T. F.

6. The wind speed may be found from the course, the heading, the wind direction, and the air speed by

solving a triangle in which we know the direction of three sides and the length of one of them. T. F.

7. We can find the wind velocity from the heading, the air speed, and a fix by solving a wind drift triangle when we know the length and direction of two sides. T. F.

8. To find the compass heading when the wind is blowing, you first find the compass course from the true course by correcting for variation and deviation and then correcting for wind drift. T. F.

9. It is possible to find the wind velocity (speed and direction) when we know the air speed, the drift angle for a heading to the north, and the drift angle for a heading to the east. T. F.

10. If you are flying to the north and see a plane approaching from the east, with a bearing that is moving clockwise, the plane will cross ahead of you. T. F.

11. To intercept a vessel, you must fly in a direction such that the bearing of the vessel from your plane is constant. T. F.

12. To intercept a vessel as soon as possible, draw its course and find a line on which the plane must be after one hour so that the bearing of the vessel from the plane will be the same as at the time of starting. T. F.

13. To intercept a vessel as soon as possible with the wind blowing, you may proceed by first finding the point to which you would drift in an hour with the wind, then find the direction to which to fly from that point to a point at the end of one hour, from which the bearing of the ship will be the same as at the start. T. F.

14. When the plane's course and heading are the same as the course of a vessel to be overtaken, the time required to overtake the vessel may be found graphically in which one dimension represents time. T.F.

15. If a pilot's cruising speed is 95 miles an hour, he can construct a scale by which to measure distance on a chart in terms of hours and minutes by dividing the distance representing 95 miles into 60 equal parts. T. F.

16. If a plane is flying a course toward the north with the wind from the northeast, the relative wind angle is 45°. T. F.

17. It is not possible to use the same wind vector for finding the heading and ground speed for a round trip. T. F.

18. For the same course and wind direction the drift angle is the same for a 200 mile air speed and a 50 mile wind as for a 100-mile air speed and a 25 mile wind. T. F.

19. The radius of action of a plane from a point A in the direction of point B is the distance the plane can fly from A toward B and return to point A or some alternative point C in the total safe flying time of the plane. T. F.

20. To find graphically the radius of action of a plane from a point A going in the direction of point B, it is necessary to draw a perpendicular bisector of line AB. T. F.

21. The formula for the radius of action is R.A. = total flying time $\times \frac{G.S.O. + G.S.I.}{G.S.O. \times G.S.I.}$ T. F.

22. The radius of action from a point A toward B with return to A is greater if the start is made downwind than if the start is made upwind. T. F.

23. The radius of action for a round trip to the starting point is greater with a relative wind at 90° to the course than with a relative wind parallel to the course. T. F.

24. If A and B are 200 miles apart and the total distance the plane can fly is 300 miles, the area of action of the plane flying from A to B is an ellipse whose length is 300 miles. T. F.

25. To find the radius of action of an airplane carrier, you have merely to treat the position of the carrier at the end of the flying time as an alternative airport. T. F.

Key to Objective Tests

Unit V

1. T
2. F
3. F
4. F
5. F
6. T
7. T
8. F
9. T
10. F
11. T
12. T
13. T
14. T
15. T
16. T
17. F
18. T
19. T
20. T
21. T
22. F
23. F
24. T
25. T

Visual Aids to the Unit

Unit V

1. Show the 32 mm. film strips:

   "Pilot Problems"

   "Air Pilotage"

   "Dead Reckoning"

   "Airway Aids"

   Jam Handy Organization, New York

Official U. S. War films together with Official British war films suitable for use with the Units on Navigation are available at small cost.

Catalog, Boston: The Visual Education Soc., Newbury Street

Catalog, Quincy: Stanley-Winthrops

Suggested References

Unit V

Wind Triangle, Interception, Radius of Action

1. "Primer of Navigation"
Mixter
D. Van Nostrand Co., N. Y., 1941

2. "Air Navigation"
Technical Manual, No. 1-205
U. S. War Dept.
Washington, D. C.

3. "Modern Flight"
Clevenger, Cloyd P.
Noble & Noble, N. Y., 1941

4. "How to Fly a Plane"
Oldham, Henry P.
Waverly House
Boston, 1940

5. "Air Piloting"
Simmons, Virgil
The Ronald Press Co.
N. Y., 1938

6. "Textbook on Aviation: The new cadet system of ground school training"
Vols. 1-2-3 and 4
Thorpe, Leslie A.
Aviation Press
San Francisco, 1935-36

7. "Aeronautics Simplified"
Vetter, Ernest G.
Foster and Stewart Publishing Corp.
Buffalo, N. Y., 1939

8. "Aeronautical Training"
Young, Charles A.
McKnight and McKnight
Bloomington, Ill., 1940

Visual Aids--The Proper Use of Films

Many studies have been made to prove the value of the sound film in motivating a subject but the war has given impetus to this form of instruction with the Army and Navy preparing many thousand feet of film for instructional purposes. Irrespective of the differences in objectives, the following techniques compiled by the Army should prove to be of value to the teacher.

1. An instructor's success in the art of teaching depends upon his preparation and ingenuity. Through careful preparation each day, he gains the respect and confidence of the students. The ingenious instructor makes the maximum use of all visual aids. This speeds up the learning process and assists the teacher in doing a more effective job.

2. A training on instructional film is a very effective aid to good instruction. But it only aids. It never replaces the instructor. The training film may be compared with the surgical instrument. Without the guidance of a skillful hand, neither will operate. When you plan to use an instructional film, take the time to use it correctly, and you will be surprised at the results.

3. Careful selection of films is important. Make sure the film brings out the exact points you want to teach your class. Don't waste time showing films that only remotely touch upon the subject. If only half a film deals with your work, show only that half, but do it well. Be familiar with the film catalogue.

4. Know your film before you show it to the class. Study it as you would a text. Pre-view the film by yourself, stop it at frequent intervals, and make notes. Remember that you must describe the film to your class before showing it, so know it well. Your thorough knowledgeof the film will help you fit it into your lesson to a better advantage.

5. The projection equipment must be completely set up and tested before the students enter the room.

(a) Hang the screen.

(b) Clean the aperture (the place the light passes through the film), and clean each end of the lens. Don't scratch it with a dirty cloth.

(c) Thread the film in the projector, and check the focus on the screen.

(d) Place the sound box near the screen. Acoustics differ in each room. Locate the sound box in the position to give the best results.

6. Never show an instructional film without telling the students what they will see. Interest them in the film. Tell them a few important things to look for. An instructional film is not designed to be entertaining, but you can arouse a great deal of student interest by an enthusiastic introduction. Remember, the film is just a tool in your hands. Use it skillfully.

7. Use instructional films under favorable conditions! Several simple precautions can assure their successful use:

(a) Provide for good ventilation, preferably cross ventilation.

(b) Use a shader box around the screen if open windows let in too much light.

(c) Arrange chairs so that students can see the screen.

(d) Use the right film at the place it fits best into the course

(e) Show only as much as students can absorb at one sitting.

8. The showing of instructional films under unfavorable conditions wastes the time of both instructors and students. The students cannot even sleep comfortably. Be sure to avoid:

(a) Poor ventilation

(b) Showing films immediately after a heavy meal.

(c) Showing films when students are exhausted at night after exercise during the day.

(d) Showing instructional films to large groups in the auditorium.

(e) Showing too many films at one sitting. (Normally 5 to 20 minutes is sufficient at one time.)

(f) Showing films without some definite purpose, which the students understand.

9. Before starting the film, the students were told what to see. Then they saw the film. Immediately after showing the film, you should discuss it with the class. Bring out the important points shown and ask questions. Then discuss other points in the picture. Make a mental note of the extent that the film was understood and remembered by the students. Try to arouse a desire to see a part or the whole film again. Whenever students fail to learn, it is evident that the instructor has not successfully taught.

10. Repeat the projection of an instructional film whenever the class can benefit by seeing the picture more times. Some films are repeated several

times, and are received with enthusiasm upon each showing, while others do not lend themselves to repeated showings. Do not bore your students with films. Never show a film, however, until the students are fully aware of just what they are looking for in the film.

11. Instructors are not mind readers. They must use some type of test to see just what the students have learned. This is an essential point in good instruction. Plan the type of test which best fits the subject matter. The test may consist of oral questions and answers to see how well students understand a problem. Or it may require written answers. Essential points, not minor details should be covered. A good test will:

(a) Provide a review for the class.

(b) Give the instructor a check on the effectiveness of his instruction.

(c) Discover points which must be reviewed.

12. A motion picture projector is just a piece of machinery. Neglect it, and it gives trouble. You should clean and oil the projector whenever it is used. The fan constantly blows dust on the film, which deposits it on the projector. Dust in the aperture is exactly in focus, and when projected, gives the edges of the picture a cloudy and irregular

appearance. Exercise care also, in rolling up the screen. Much of this equipment is expensive and cannot be replaced. Make each use of instructional films a pleasurable and profitable experience. You as an instructor, can assure this.[1]

[1]Pre-Induction Training Visual Aids Catalogue. First Service Command., U. S. Army Signal Corps.

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